Space Weather Technical Forecast

Issued on Thursday, 13 January 2022 at 00:50 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storm intervals likely, most probably day 3 (15th). Solar activity increasing through the period as far-side regions rotate into view.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low in the last 24 hours. A long period B9 flare was observed around 12/0500 from over the northeastern limb, with significant plasma ejection and associated far-sided CME. This was likely from AR2821 on the previous rotation, and would have been notably stronger without the occlusion from the Sun. This region is due back onto the Earth-side later day 1 or day 2 (13th/14th).

There are six sunspot containing active regions currently on the Earth-facing disc. Three of these are mature features, with the largest AR2924, Fho/Beta in the southwest which has been generally stable and inactive. AR2925 and AR2927 are both small remnant Hsx/alpha regions in the southern hemisphere. AR2926 Cri/Beta in remains a small region, but has been showing some erratic evolution in the last 24 hours. AR2828 Dso/Beta developed in the southern centre disc, but is currently a small and simple region. A further unnumbered small Bxo/Beta region developed in the northwest.

No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar wind speed as observed by DSCOVR at L1 have increased from background levels near 350 km/s to slightly elevated at around 410 km/s. The density of the wind was at or below average. Total interplanetary magnetic field (IMF) strength, Bt, was mainly weak, peaking 8nT, with the Bz component also varying weakly between -4 and +6 nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout. High energy electron flux (greater than 2MeV) was at background levels throughout. Electron fluence remained steady and below the Active threshold (1e8 integrated pfu), with 2.02e6 integrated pfu recorded at 13/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with a slight chance of this increasing to moderate. This risk increasing a little by day 3 (15th) as far-sided regions approach or move around the eastern limb.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Background solar winds are expected to persist until the arrival of the fast winds of coronal hole 44. This is most likely to occur on day 3 (15th), but with a slight chance of an early arrival late 14th. Mainly Quiet geomagnetic activity expected until this arrival, becoming Active to G1/Minor Storm as it occurs, with a slight chance of G2/Moderate Storms. Declining to Quiet to Unsettled, with Active intervals and slight chance of G1/Minor Storms day 4 (16th)

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at background levels. The high energy electron flux (greater than 2MeV) is

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expected to remain near background until after the arrival of the fast wind of coronal hole 44. Flux then likely increasing to Moderate to High day 4 (16th). The associated 24 hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of the period, but with a chance of reaching the Active threshold by the end of day 4 (16th).

Figure 1. SDO-304 time-lapse showing plasma eruption from far-side flare (top) with flare location visible on STEREO A euvi (bottom)

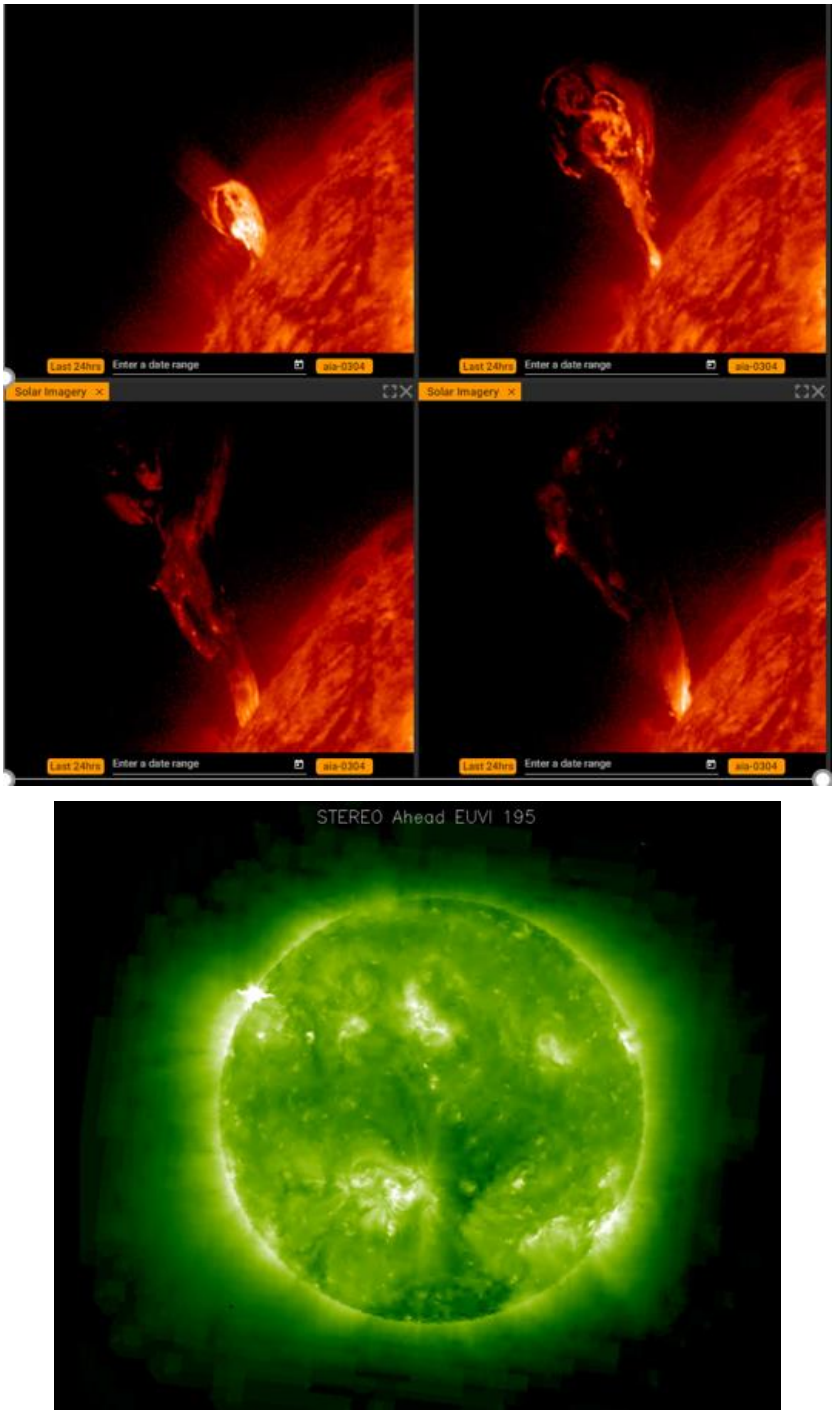

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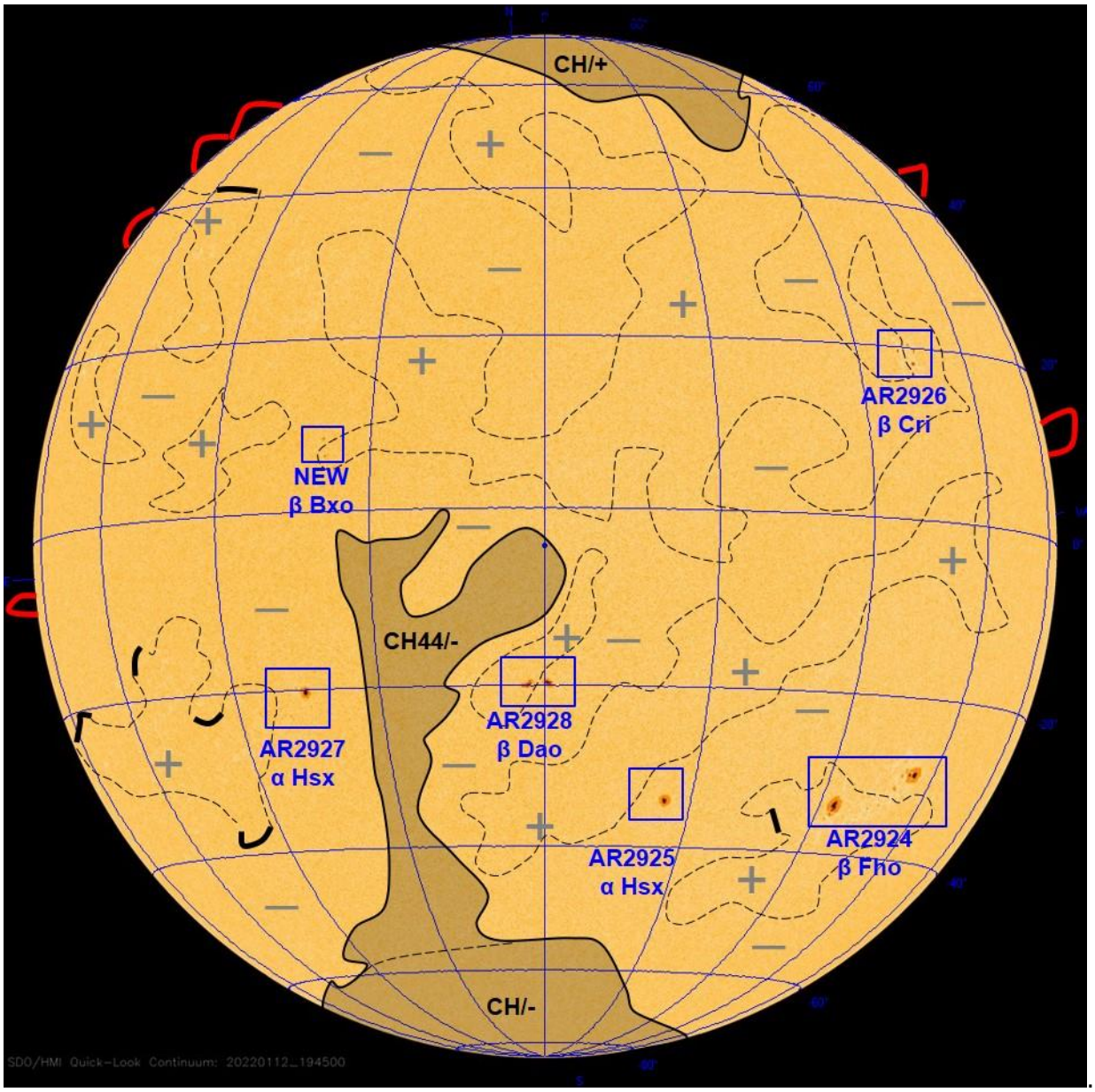
Figure 2. Solar Analysis Valid 12/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

Current background solar winds are expected to persist day 1 and probably day 2 (13th and 14th) before the arrival of the fast wind of coronal hole 44, most likely early day 3 (15th). Solar winds are likely to reach around 600 km/s and remain elevated day 4 (16th). There is some uncertainty on the timing, with enlil currently suggesting arrival on the 13th, whilst STEREO A has seen both increased density followed by increased speed on the 12th, whilst observing conditions 2.7 days ahead of Earth, so corresponding to late day 2 or early day 3 (14th/15th). Persistence would suggest arrival later on the 15th, however the coronal hole structure is markedly changed from the previous rotation.

Quiet geomagnetic activity day 1 (13th) and day 2 (14th) is expected to become Active to G1 Minor Storm, with a slight chance of G2 Moderate Storms day 3 (15th), along with a slight chance of an early arrival late day 2 (14th). Activity easing to Quiet to Unsettled with Active intervals, and a slight chance G1/Minor storms day 4 (16th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 3: Solar wind persistence Model

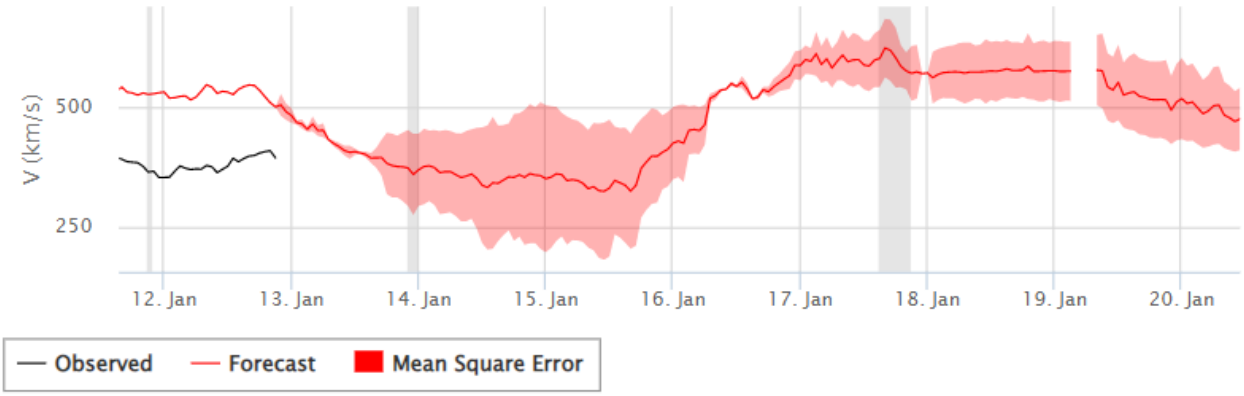

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Figure 3: Enlli solar winds

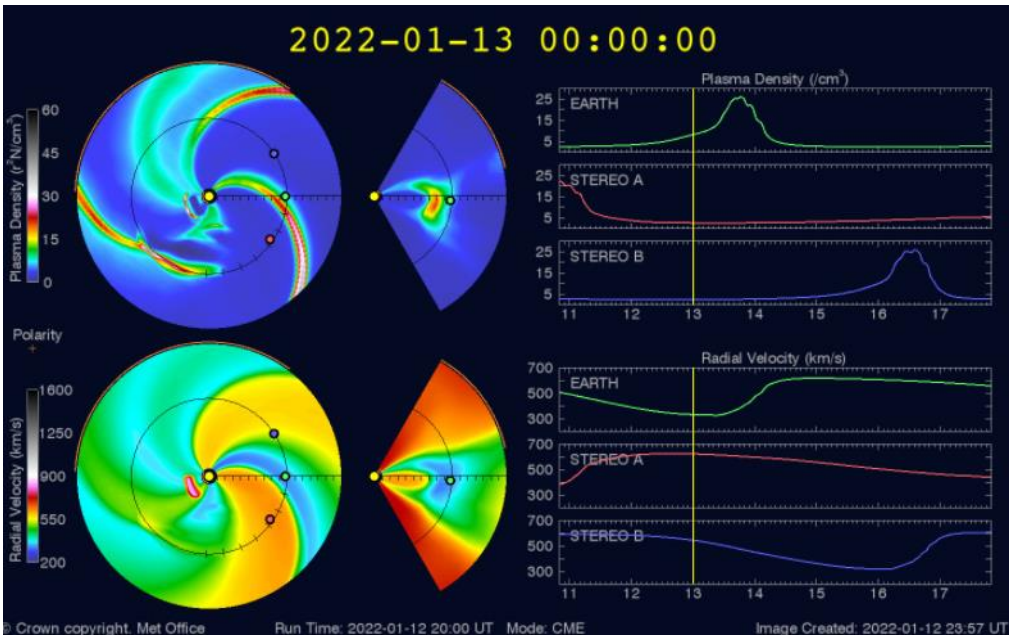


Figure 4: SDO aia-211 of previous rotation (left) and current rotation (right)

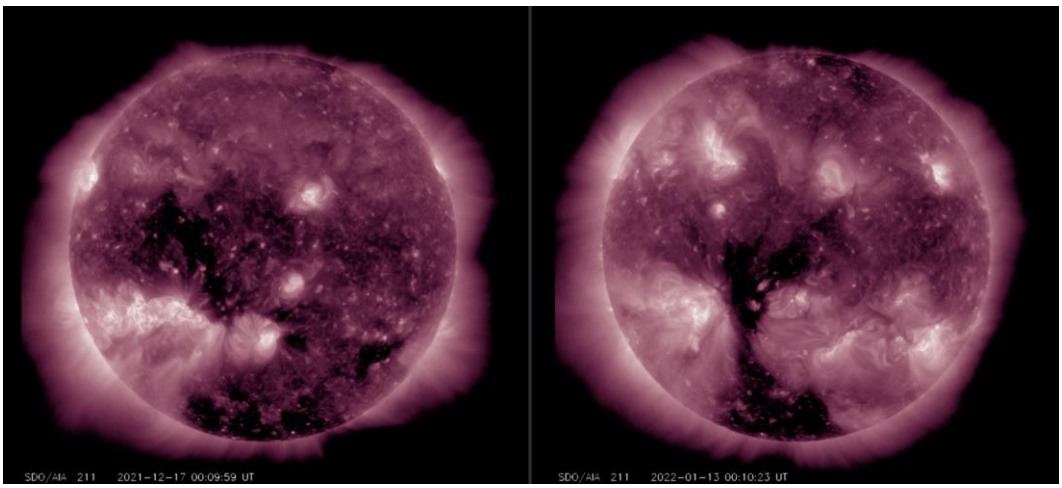
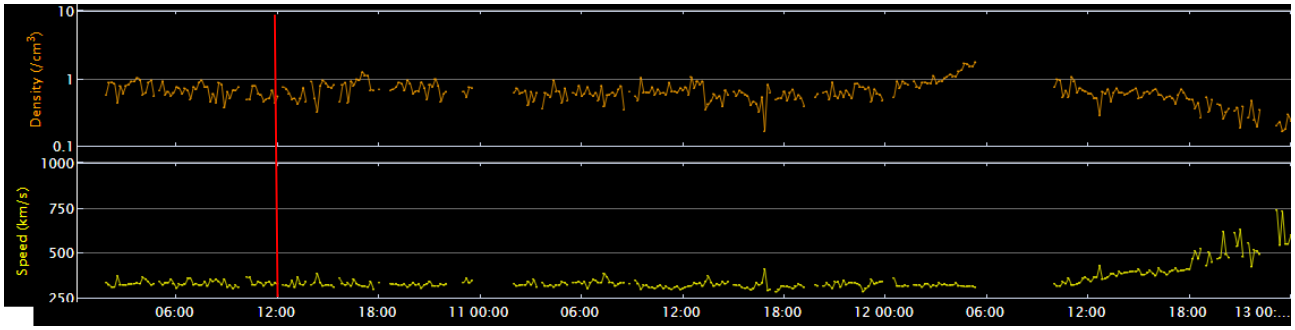


Figure 5: STEREO A observed Solar winds (current equivalent Earth position indicated by red line) Increased solar winds arriving around the start of equivalent day 3, with increased density late day 2.



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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Very Low with only one B9 flare observed, from over the eastern limb at around 12/0500 UTC, although this would have been a much stronger flare when taking account of the occlusion from the Sun. There are 6 sunspot regions on the Earth-side, however no notable flares have been observed from these regions.

AR2924 Fho/Beta in the southwest is the largest region, but magnetically simple and has been stable throughout its transition across the southern hemisphere, although some erratic development of intermediate spots has been observed at times. AR2925 Hsx/alpha and AR2927 Hsx/alpha, also in the southern hemisphere have persisted as small mature and inactive regions. AR2926 Cri/Beta in the northeast has seem some dynamical evolution, but any growth has been minimal, with no notable flares observed. AR2828 Dao/Beta developed in the southern centre disc in the last 24 hours, and while further growth is possible, is currently small and simple, with no notable shear or instability. A further new, currently unnumbered small Bxo/Beta spot has also developed in the northeast disc. Despite these sunspots activity is currently expected to be Very Low to Low, with only a slight chance of M-flares.

Later day 1 and through day 2 (13th and 14th), the far-side flare source region, likely AR2921 from the previous rotation, is expected to rotate onto the disc. A further large far-side sunspot (AR2918) is also signalled to rotate onto the disc day 4 (16th). This brings a slightly increased chance of M-flares (R1/R2 Blackouts) day 3 (15th) onward.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	15	15
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 6: GOES-16/17 X-ray flux Long period B9 flare visible.

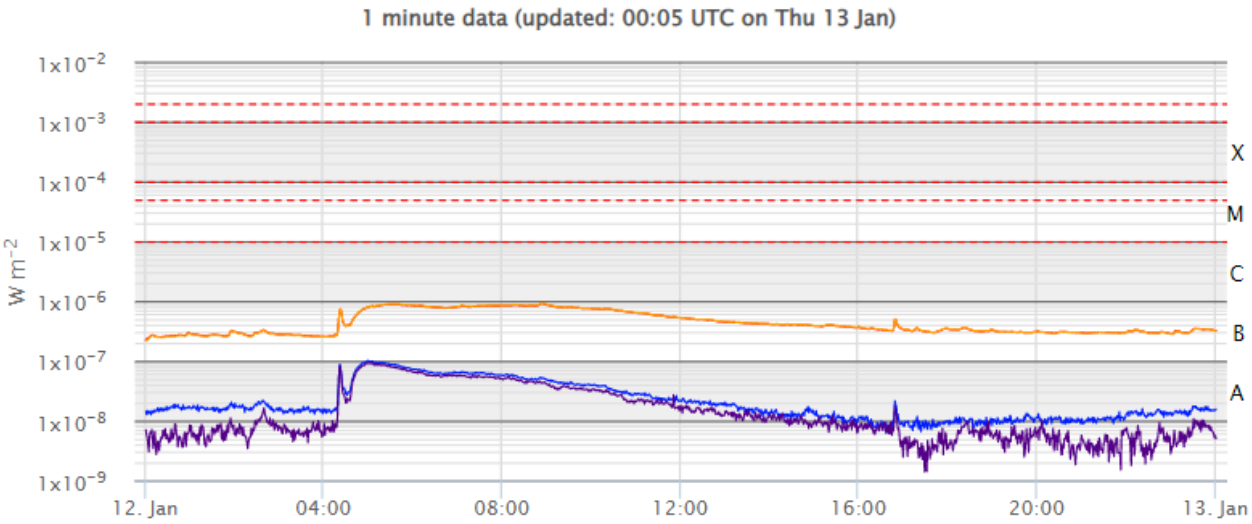

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Figure 7: SDO Magnetogram and Intensitygram of southern hemisphere spots

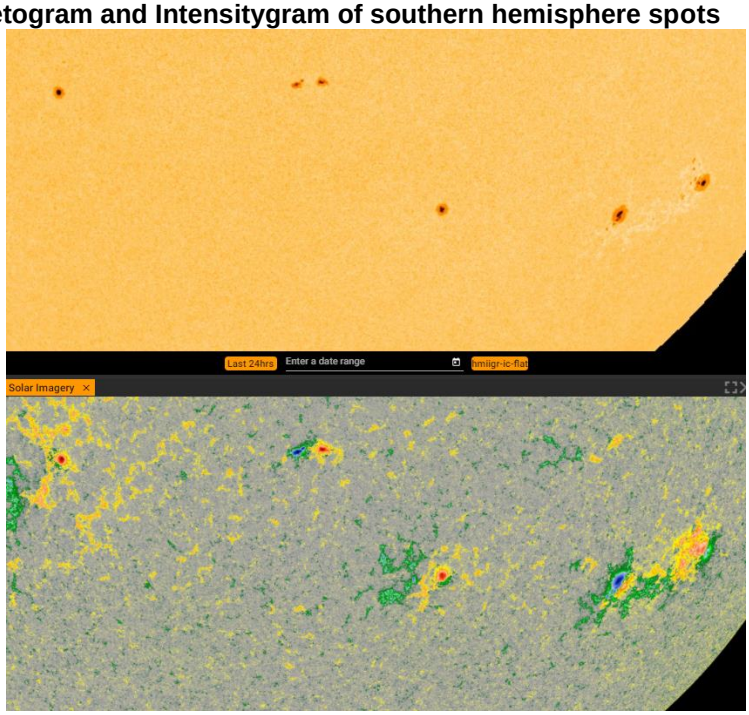
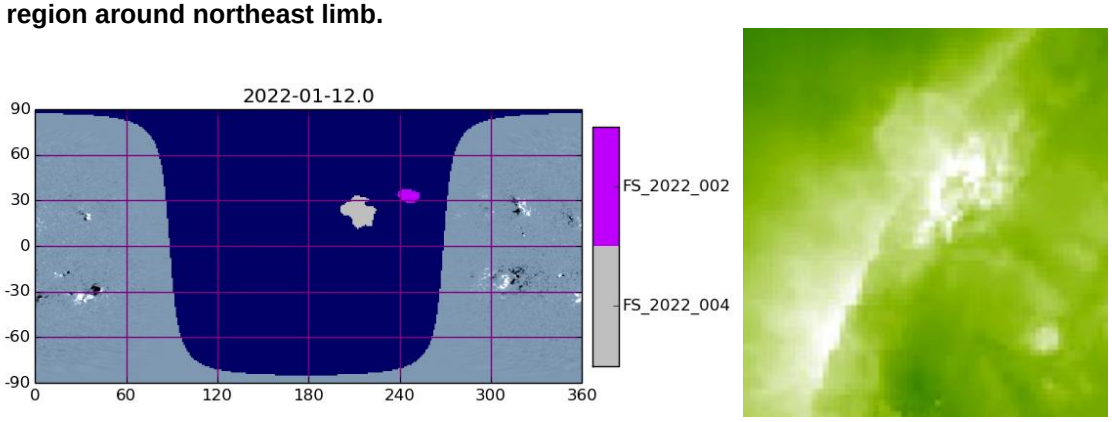


Figure 8: Helioseismic signal of far side regions (left) with zoomed STEREO-A euvi (right) of anticipated region around northeast limb.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist at this level in the absence of solar activity.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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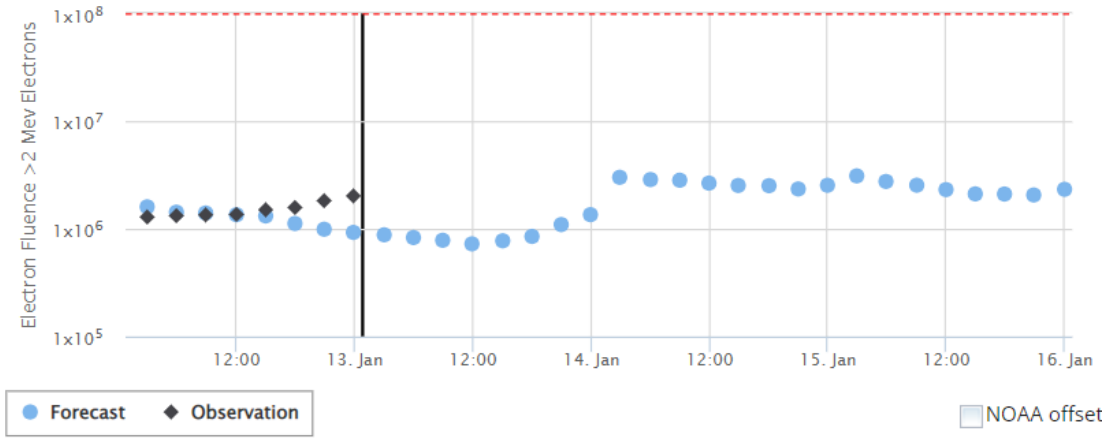
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been at background levels. Despite recent solar wind enhancement from the fast wind of CH43, there has been little sign of the electron population increasing as winds ease. There is still a chance of some moderate flux occurring through the period, however it looks likely that levels will remain below the alert level (1000 pfu) until after the arrival of the fast wind of CH44. This is forecast to occur on day 3 (15th) with a subsequent increase likely through day 4, potentially to alert levels but with low confidence.

The associated 24 hour electron fluence is below the Active threshold and expected to persist at this level until at least the end of day 3 (15th). This is supported by REFM, which is currently giving good guidance. There is then an increasing chance of Active fluence later day 4 (16th), due to any increased flux from the arrival of the fast wind of CH44.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 9: GOES-16 >2MeV Electron Fluence with REFM



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